



# GES-DISC Interactive Online Visualization AND aNalysis Infrastructure (Giovanni)

- 🌐 With Giovanni and a few mouse clicks, one can easily obtain information on the atmosphere around the world.
- 🌐 There is need to learn data formats to retrieve and process data.
- 🌐 You can try various combinations of parameters measured by different instruments.
- 🌐 All the statistical analysis is done via a regular web browser.

<http://giovanni.gsfc.nasa.gov/>

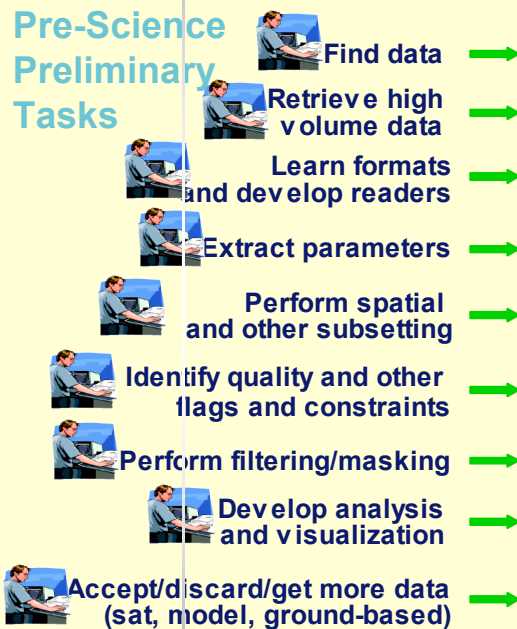
***Caution: Giovanni is a rapidly evolving data  
exploration tool!***



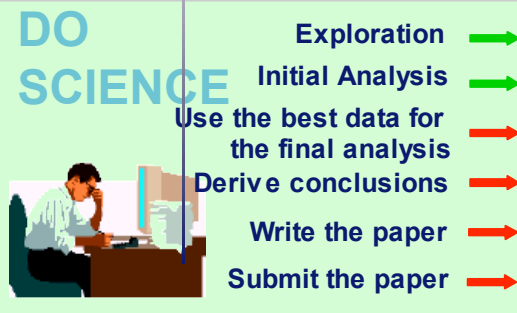
# GES DISC Tools Allow Scientists to Concentrate on the *Science*

## The Old Way:

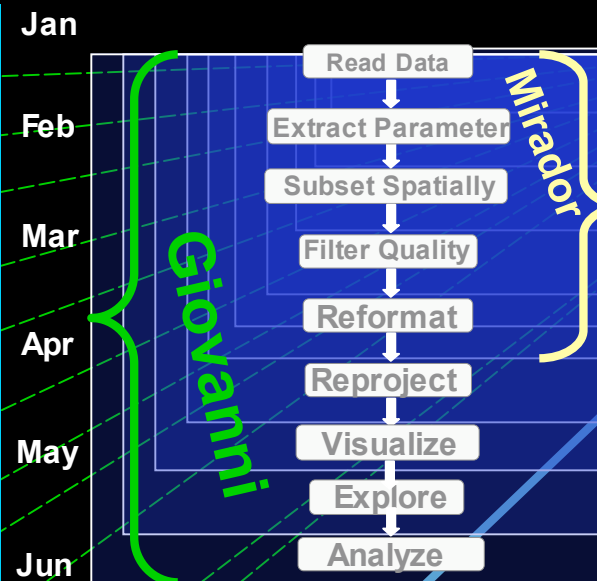
### Pre-Science Preliminary Tasks



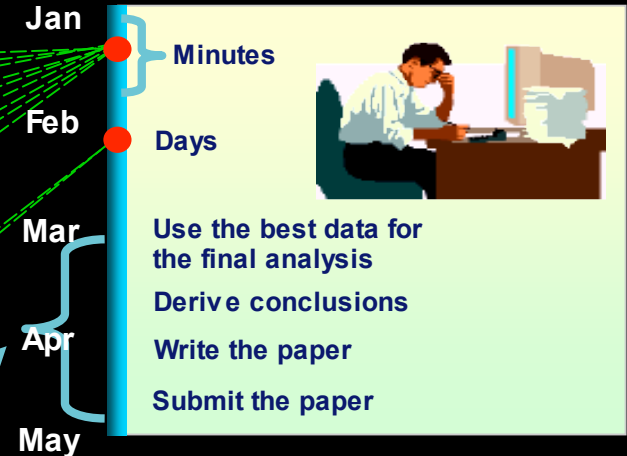
### DO SCIENCE



## Web-based Services:



## The GES-DISC Way:

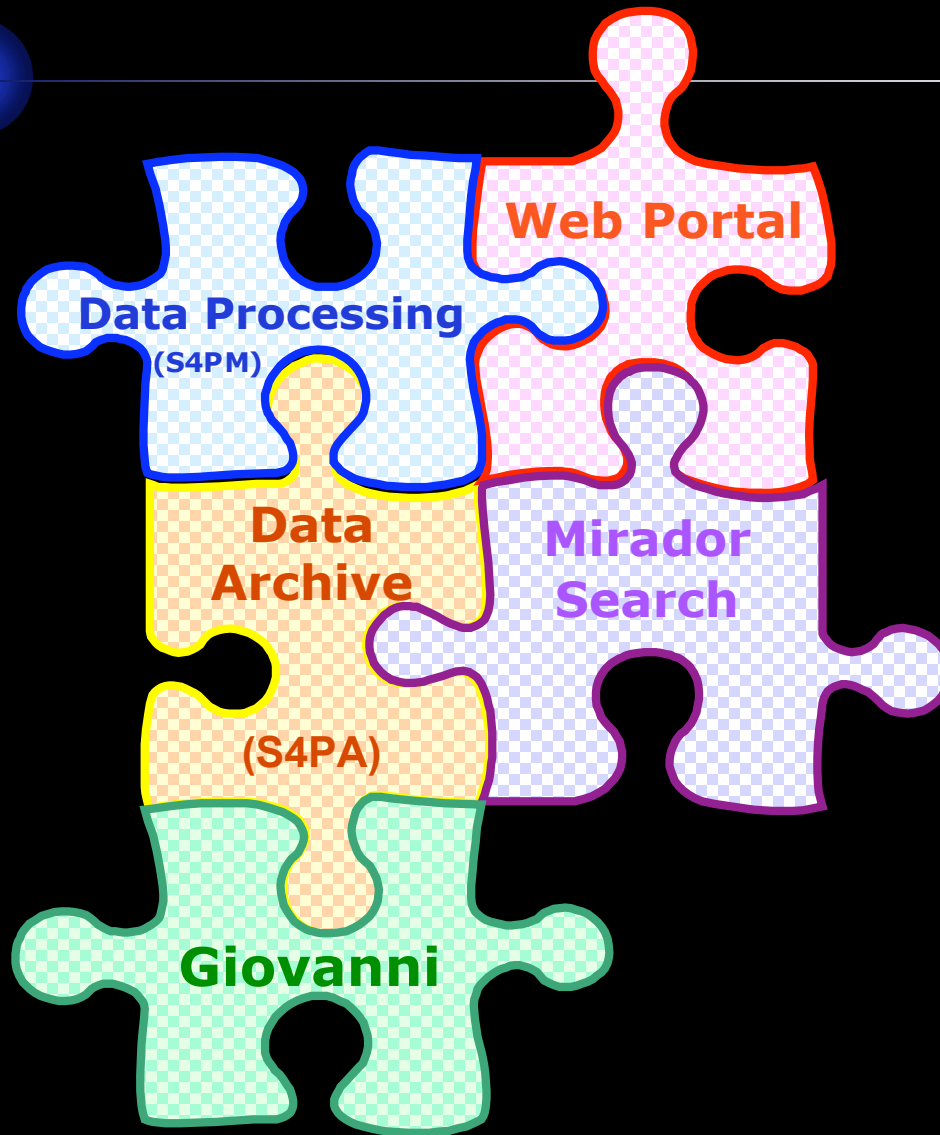


GES DISC tools allow scientists to **compress** the time needed for pre-science preliminary tasks: *data discovery, access, manipulation, visualization, and basic statistical analysis.*

Scientists have **more time to do science.**



# Current GES DISC Configuration



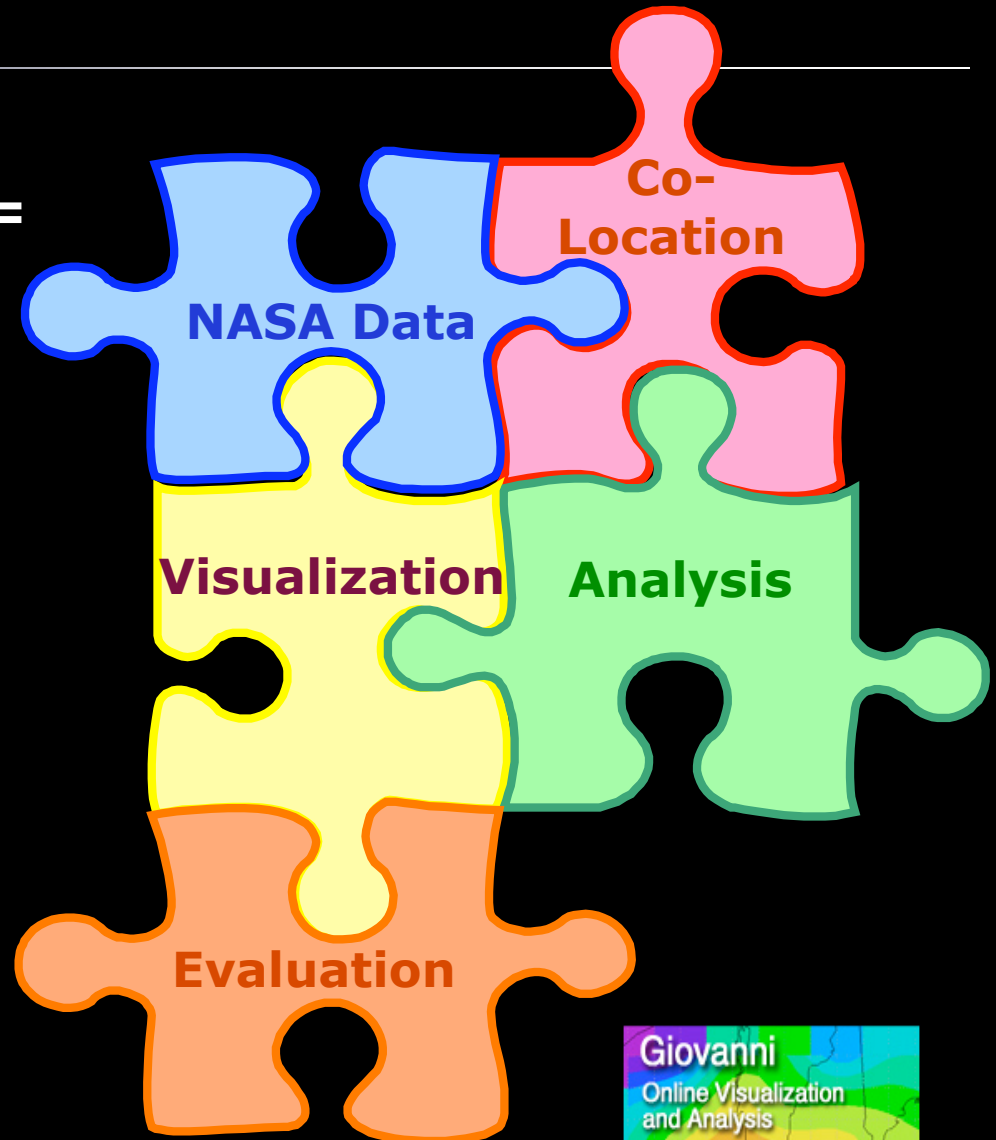
The GES DISC manages the data management tasks: satellite data processing (S4PM), data archiving (S4PA), searching (Mirador), subsetting (Mirador), Web access (portal); as well as enable the science implementation (*via Giovanni*).



# Current Giovanni Configuration



=



Giovanni is a Web-based application that provides a simple and easy way to visualize, analyze and access vast amounts of Earth science remote sensing data.

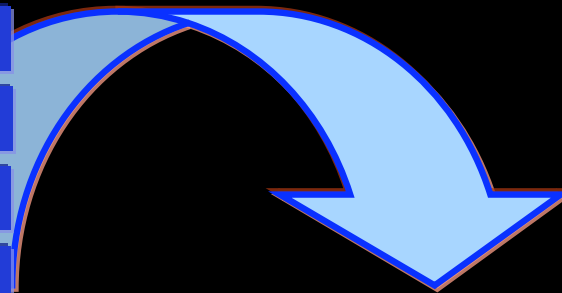






# What data goes into Giovanni?

Data Inputs	
MLS	Aura
OMI	Aura
AIRS	Aqua
MODIS	Aqua
MODIS	Terra
SeaWiFS	
TRMM	
HALOE	UARS
TOMS	EP, N7
AMSR-E	Aqua
MISR	Terra
CloudSat	
CALIOP CALIPSO	
MERRA Models	



## Giovanni Instances

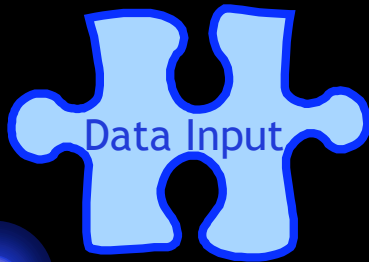


Giovanni is already a powerful tool for the analysis of many Earth science satellite datasets.

The next obvious step in its evolution is the inclusion of additional ground-based, field campaign and model data into Giovanni.



Data Input

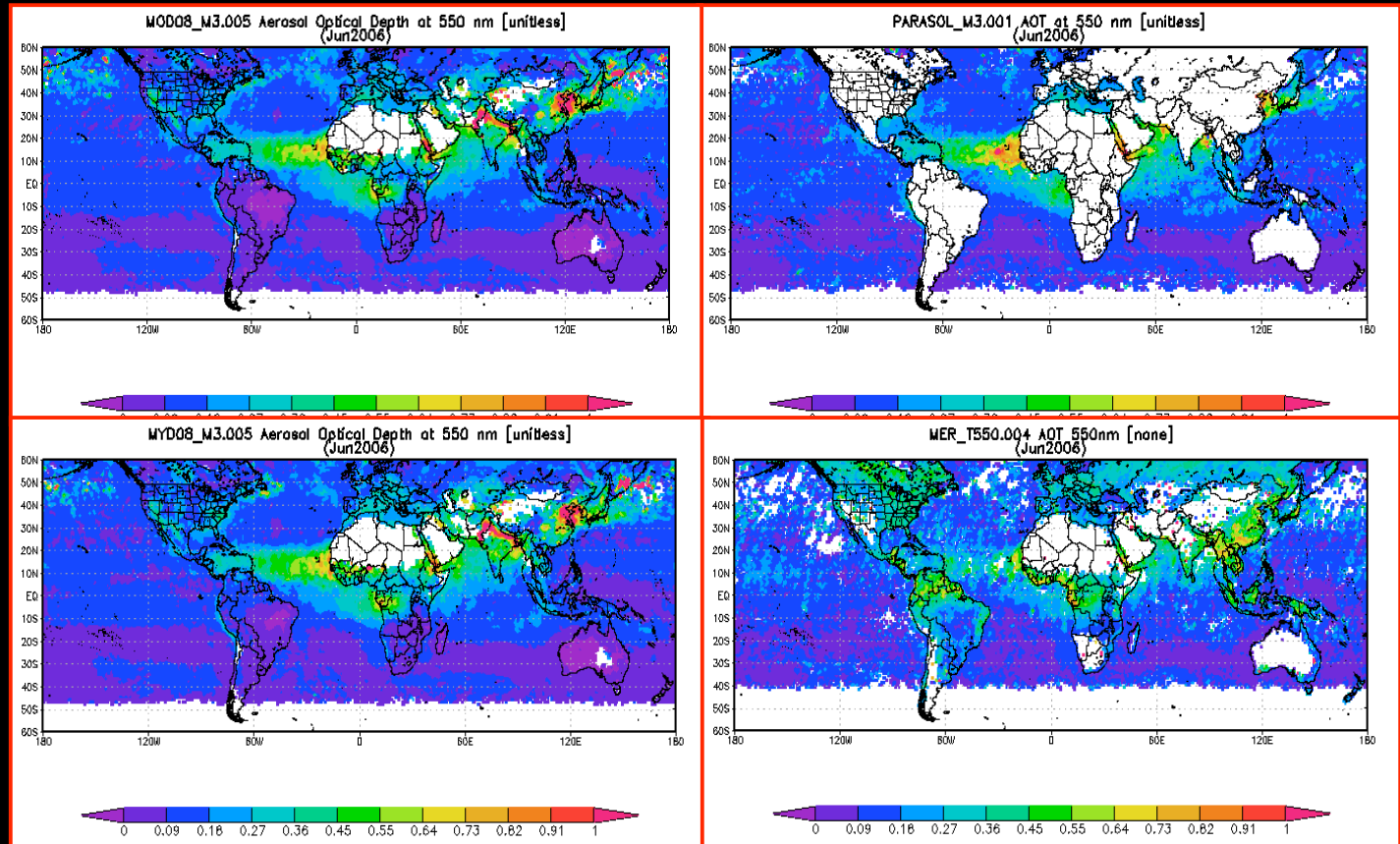
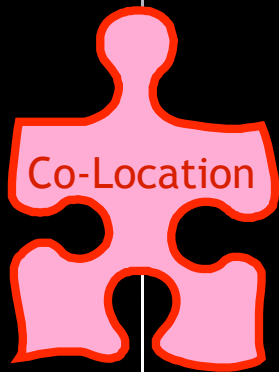


# and their Access Protocols

Data sources	Protocol	Data
NASA GES DISC	Local access	AIRS, TRMM, OMI, MLS, HIRDLS
NASA MODIS DAAC	FTP	MODIS
NASA Ocean Color DAAC	FTP	SeaWiFS, MODIS
NASA Langley DAAC	OPeNDAP	CALIPSO, MISR, <i>TES</i> , <i>CERES</i>
NSIDC	FTP	AMSR-E
NOAA	FTP	Snow, Ice, NCEP
Univ. of Maryland	FTP	MODIS fire, NDVI
Colorado State Univ.	FTP	CloudSat
CIESIN Columbia University	FTP	Population
JPL	FTP	QuickSat
EPA via DataFed	WCS	PM2.5
Lille, France	FTP	Parasol
ESA	FTP	MERIS
Juelich, Germany	FTP → WCS	<i>HTAP</i>
Paris, France	OPeNDAP	<i>AEROCOM</i>



# Aerosol Optical Depths for June 2006



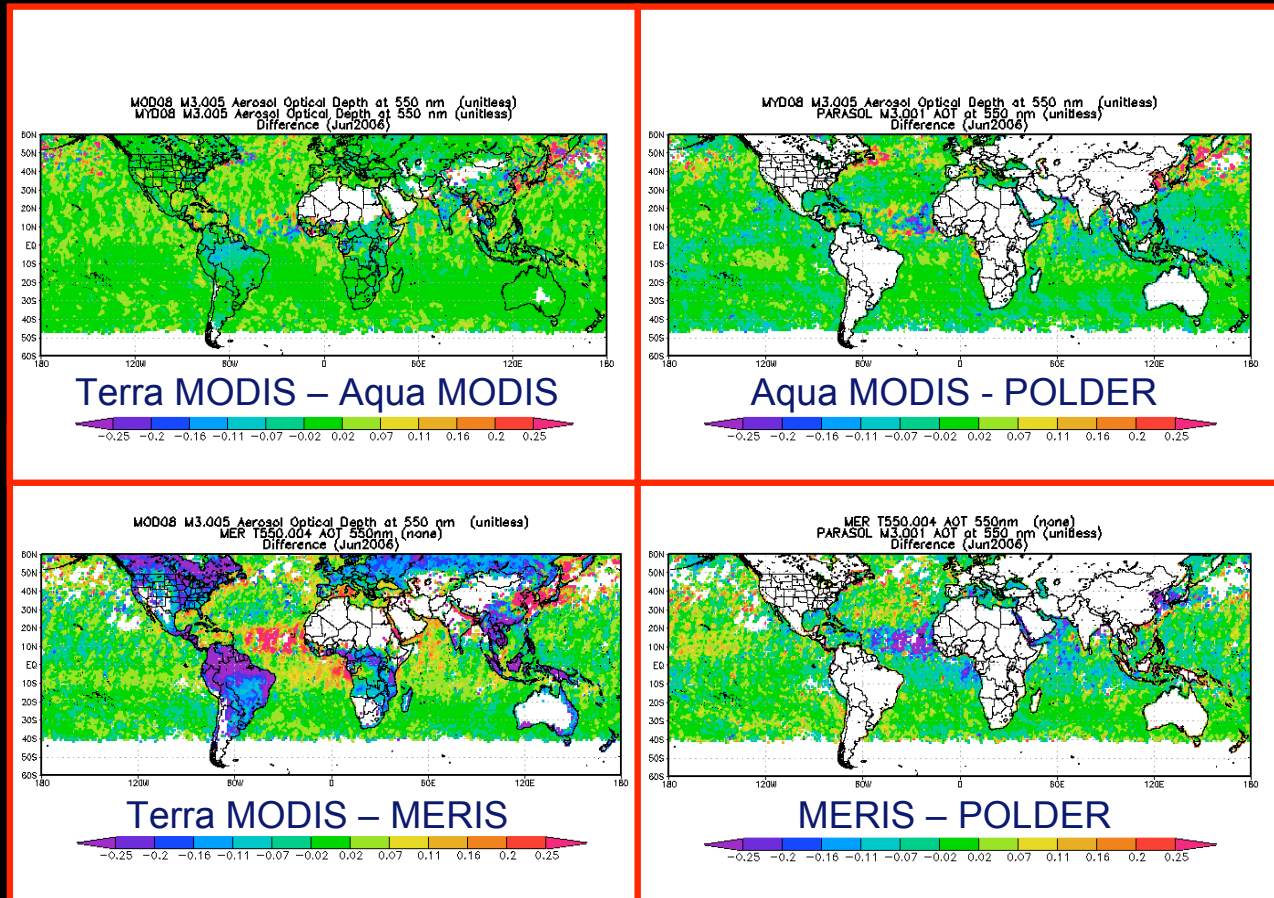
Co-Location on a common spatial grid enables comparison of regional and global aerosol features. Once co-located, Giovanni allows for spatial and temporal subsetting of the data.



# AOD Differences for June 2006

Co-Location

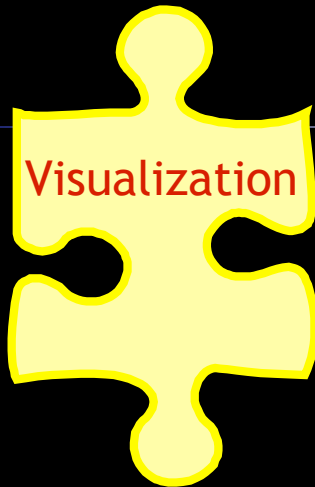
Visualization



Once all data has been placed on a **common Level 2G grid**, the calculation of differences (and other data manipulation) becomes trivial.

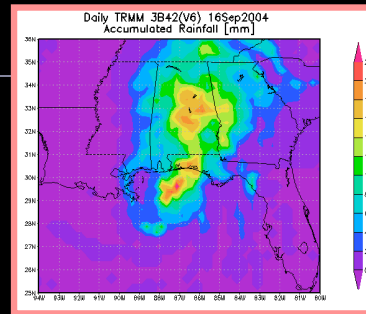


# What can we get out of Giovanni?

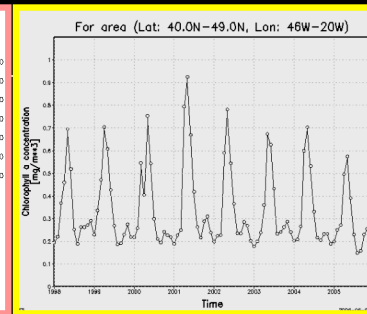


Giovanni provides an entire suite of statistical analysis and visualization tools for the comparison of regional and

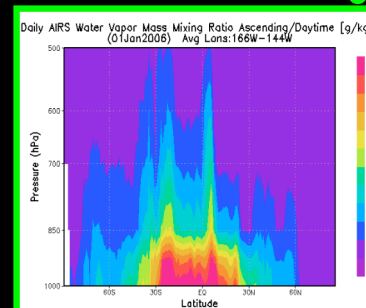
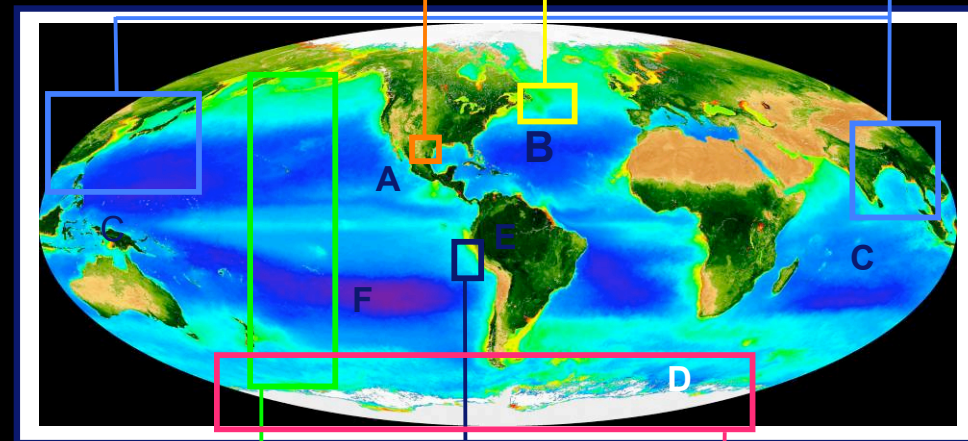
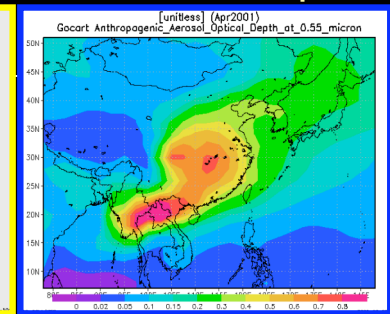
Area Plot



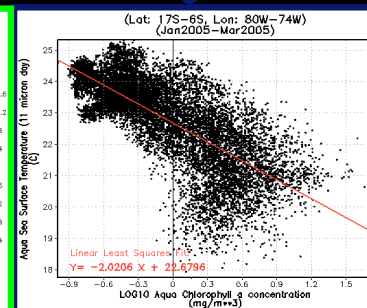
Time Series



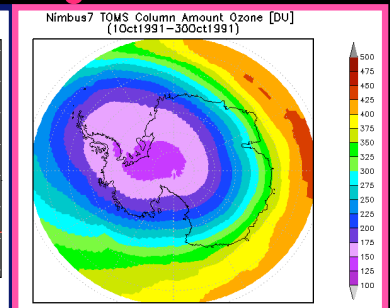
Model Output



Profile Cross-Section

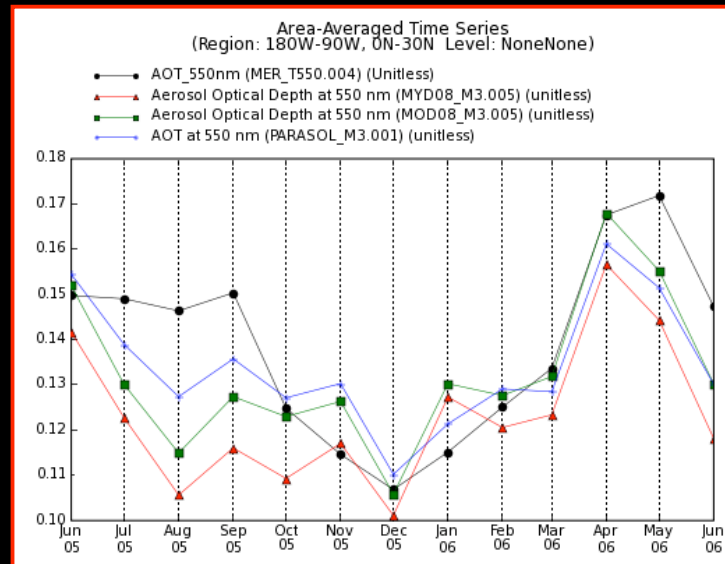
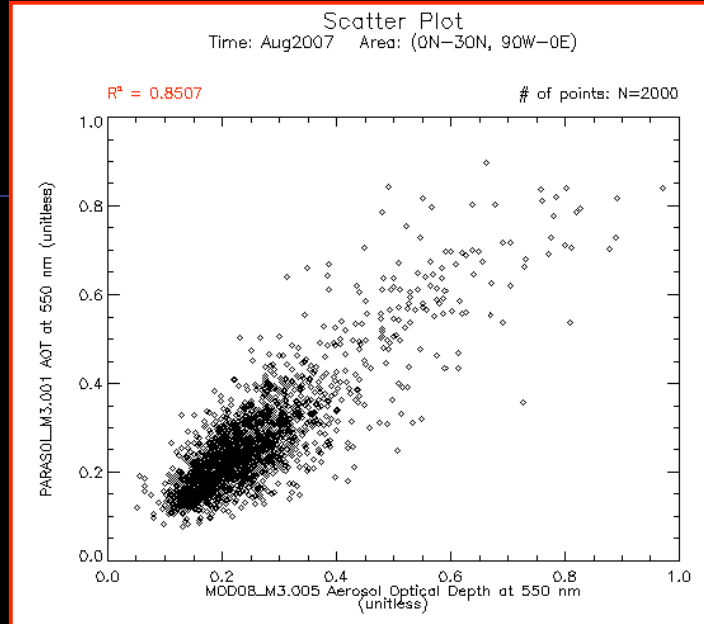
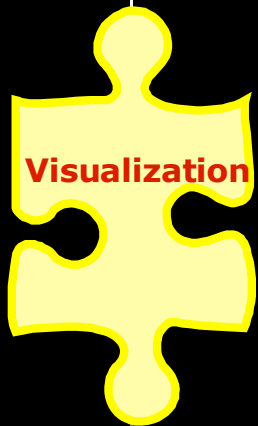
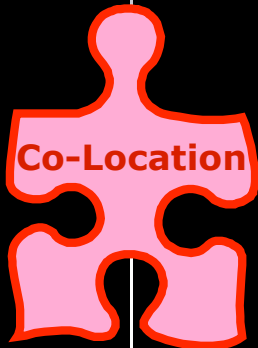


Correlations



Column Densities





Co-location on a ***common Level 2G grid*** enables the calculation of statistical analyses, such as:

- 🌐 scatter plots
- 🌐 correlation maps
- 🌐 difference maps
- 🌐 regression analysis
- 🌐 time-series
- 🌐 climatologies
- 🌐 anomaly maps
- 🌐 Taylor diagrams
- 🌐 etc.



# Giovanni Capabilities



## Basic (one-parameter):

- 🌐 Area plot - averaged or accumulated over any data period for any rectangular area (various map projections)
- 🌐 Time plot - time series averaged over any rectangular area
- 🌐 Hovmöller plots - longitude-time or latitude-time cross sections
- 🌐 ASCII output - for all plot types (can be used with GIS apps, spreadsheets, etc.)
- 🌐 Image animation - for area plot
- 🌐 Vertical profiles
- 🌐 Vertical cross-sections, zonal means

## Beyond basics:

- 🌐 Area plot - geographical intercomparison between two parameters
- 🌐 Time plot - an X-Y time series plot of several parameters
- 🌐 Scatter plot of parameters in selected area and time period
- 🌐 Scatter plot of area averaged parameters - regional (i.e., spatially averaged) relationship between two parameters
- 🌐 Temporal correlation map - relationship between two parameters at each grid
- 🌐 Temporal correlation of area averaged parameters - a single value of the correlation coefficient of a pair of selected parameters
- 🌐 Difference plots
- 🌐 Anomaly plots
- 🌐 Acquiring parameter and spatial subsets in a batch mode through Giovanni



# Giovanni Capabilities

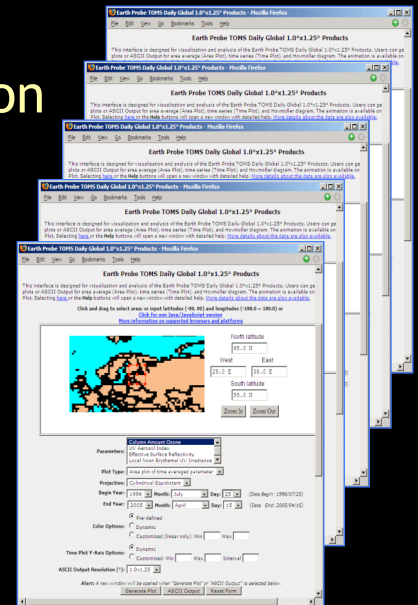
Evaluation

**Flexibility** is the key to providing a useful platform for comparison, analysis and evaluation of aerosol data.

The **user** defines:

- horizontal spatial resolution, temporal resolution
- vertical spatial resolution (when relevant)
- Web browser (Explorer, Mozilla Firefox, Safari)
- statistical tools
- quick-look options, color palettes
- Taylor diagrams for multivariate comparisons\*
- spatial re-gridding options\*
- data fusion/merger options\*
- empirical corrections\*
- data output options (NetCDF, HDF, ASCII, KMZ (Google Earth), XML, binary, IDL\*, MATLAB\*)

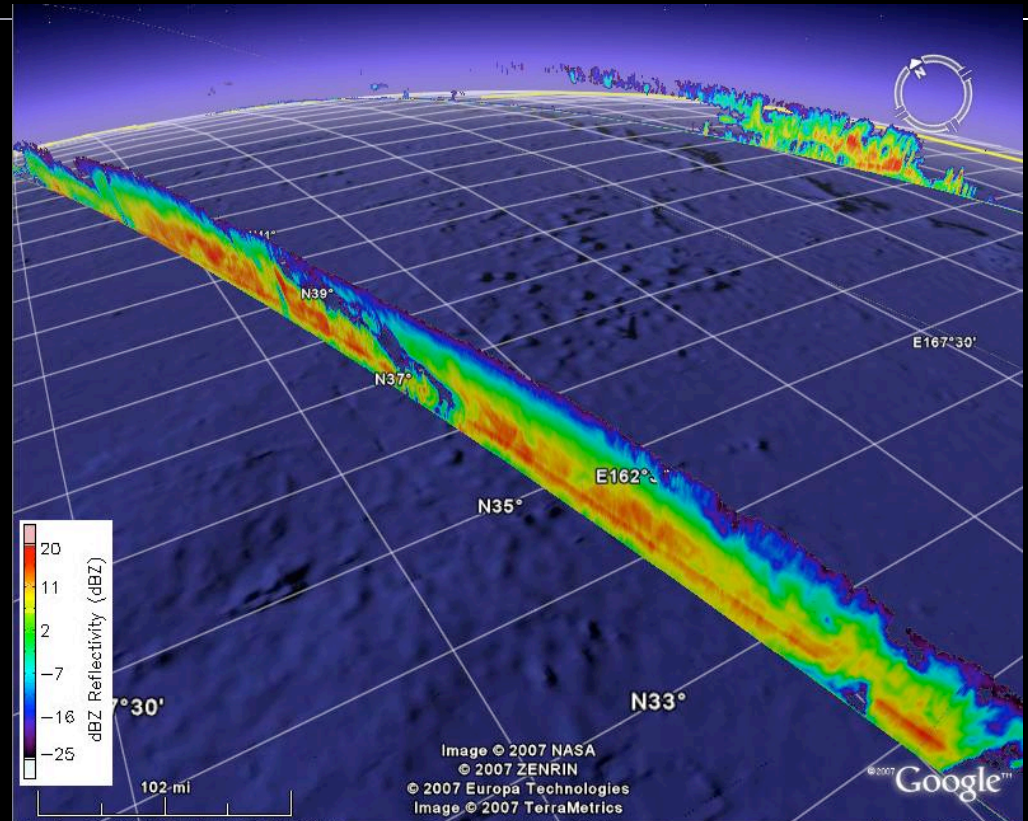
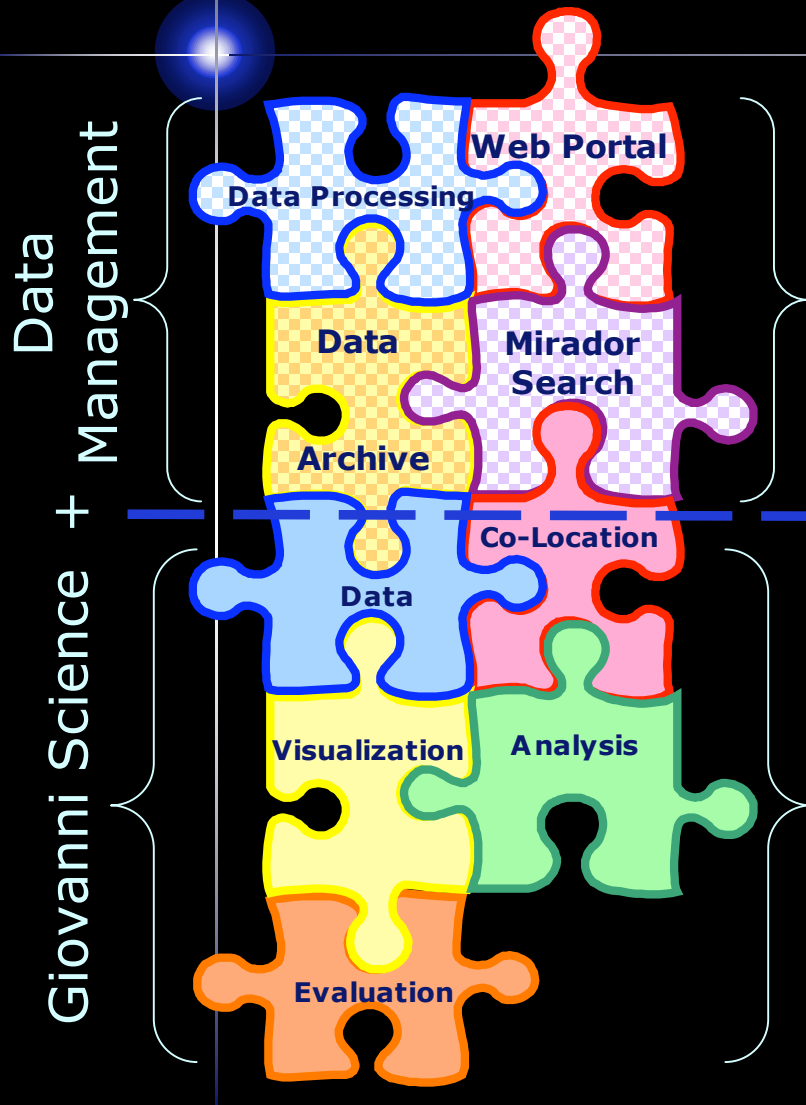
\*coming soon!







# Putting It All Together



= Export Data to



**Putting NASA Data on the Map!**



# Externally-funded Giovanni-related projects

## Project Name

NASA Data Integration into Global Agricultural Decision Support Systems Project (Steve Kempler, REASoN CAN 02-OES\_01).

Enhancing NOAA AWIPS DSS by Infusing NASA Research Results for Drought and Other Disaster Management

A-Train Data Depot, Steve Kempler, NNH05ZDA001N-ACCESS

NASA NEESPI Data Center, Gregory Leptoukh, NNH05ZDA001N-ACCESS

Monsoon Asia Integrated Regional Study in Eastern Asia (MAIRS), Leptoukh, LCLCUC

Aerosol Integrated Inter-comparison and Validation Project, Charles Ichoku, ACCESS

3-D VIS for A-Train, Steve Kempler, ACCESS

Long-Term Aerosol Data Records, Christina Hsu, NNH06ZDA001N-MEASURES

Ocean Color Time-series Project, Watson Gregg, REASoN CAN-02-OES-01

Multi-sensor Data Science Advisor, Leptoukh, AIST (ESTO)



# Unsolicited Giovanni-related Projects

Project Name
HSB-GLDAS and HSB-NLDAS (Rodell)
GOCART Data into Giovanni (Mian Chin)
Ocean Color model data (Watson Gregg)
MERRA data into Giovanni (Mike Bosilovich)
HTAP (Terry Keating from EPA and Lawrence Friedl)
Langley NRT(Calipso and GE)
Langley CERES into Giovanni
Langley TES into Giovanni



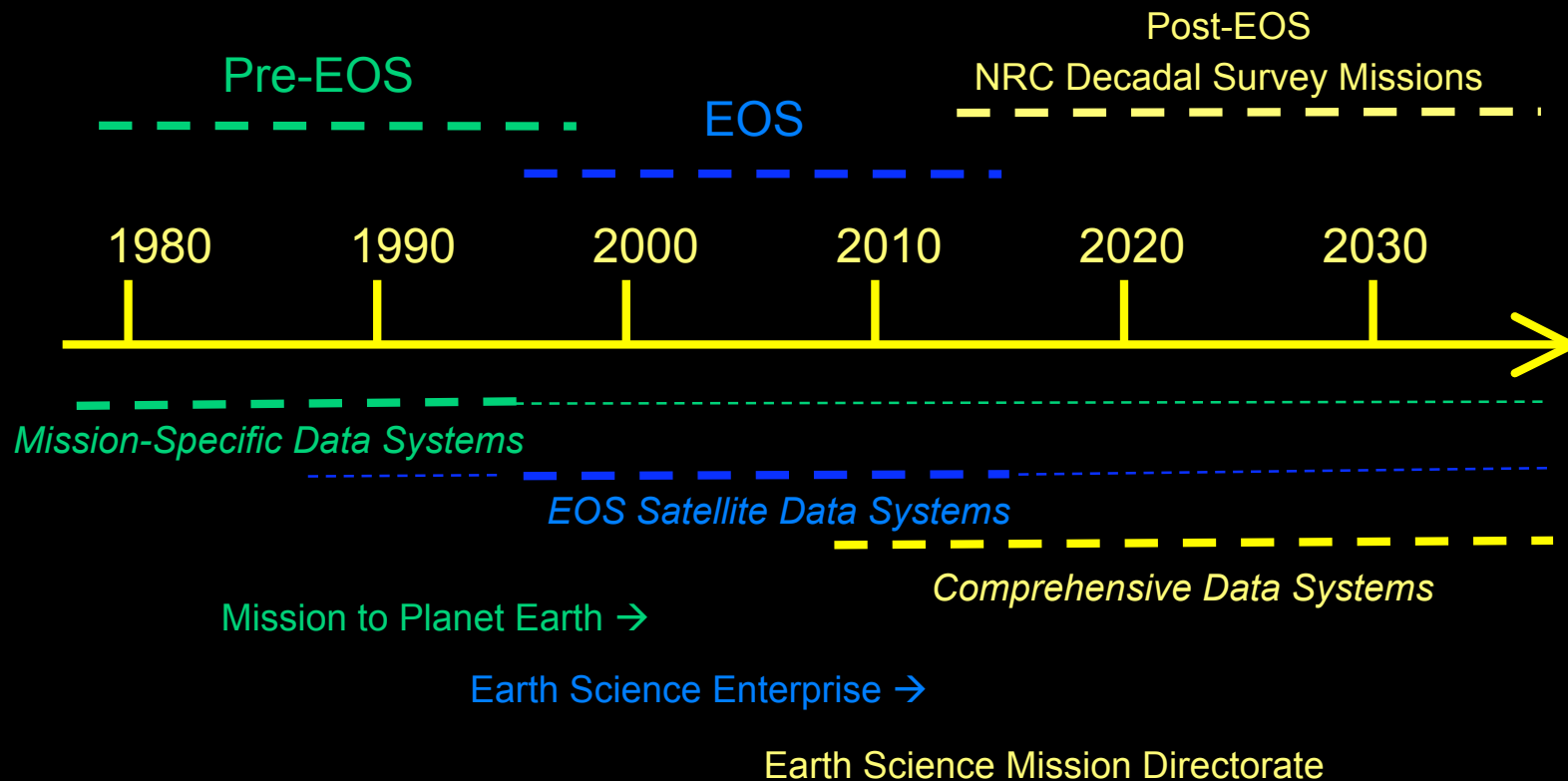
# Moving Beyond EOS

“The space-based components of NASA’s Earth science program provide a constellation of satellites to study Earth from space. Sustained observations allow researchers to monitor Earth’s climate variables over time to determine trends; however, launching satellites alone is not sufficient. A **comprehensive data and information system**, a community of scientists performing research with the data acquired, and extensive ground and airborne campaigns are all important components. More than any other factor, the commitment to make Earth science data easily available to the research community is critical to mission success.”

-- *2006 EOS Science Reference Handbook, p. 2*



# Data System Evolution Overview





# What directions should Giovanni emphasize?

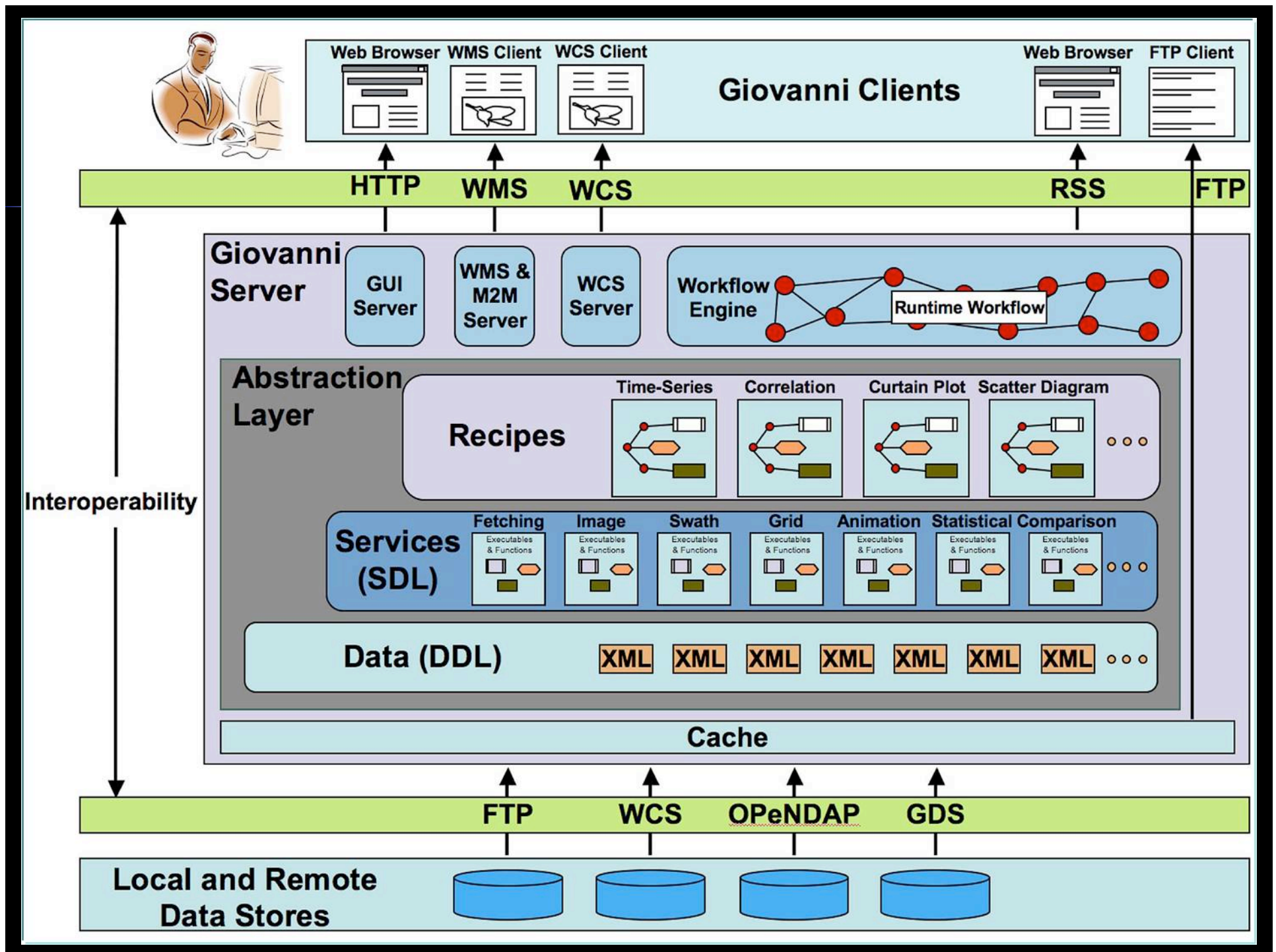
- 🌍 hierarchy of disciplines
- 🌍 enhance analysis component
- 🌍 more remote sensing data (L2?)
- 🌍 more models
- 🌍 ground-based measurements
- 🌍 multi-sensor/model intercomparisons
- 🌍 more user-friendly
- 🌍 science quality/provenance
- 🌍 data fusion
- 🌍 QA/validation



# Backup



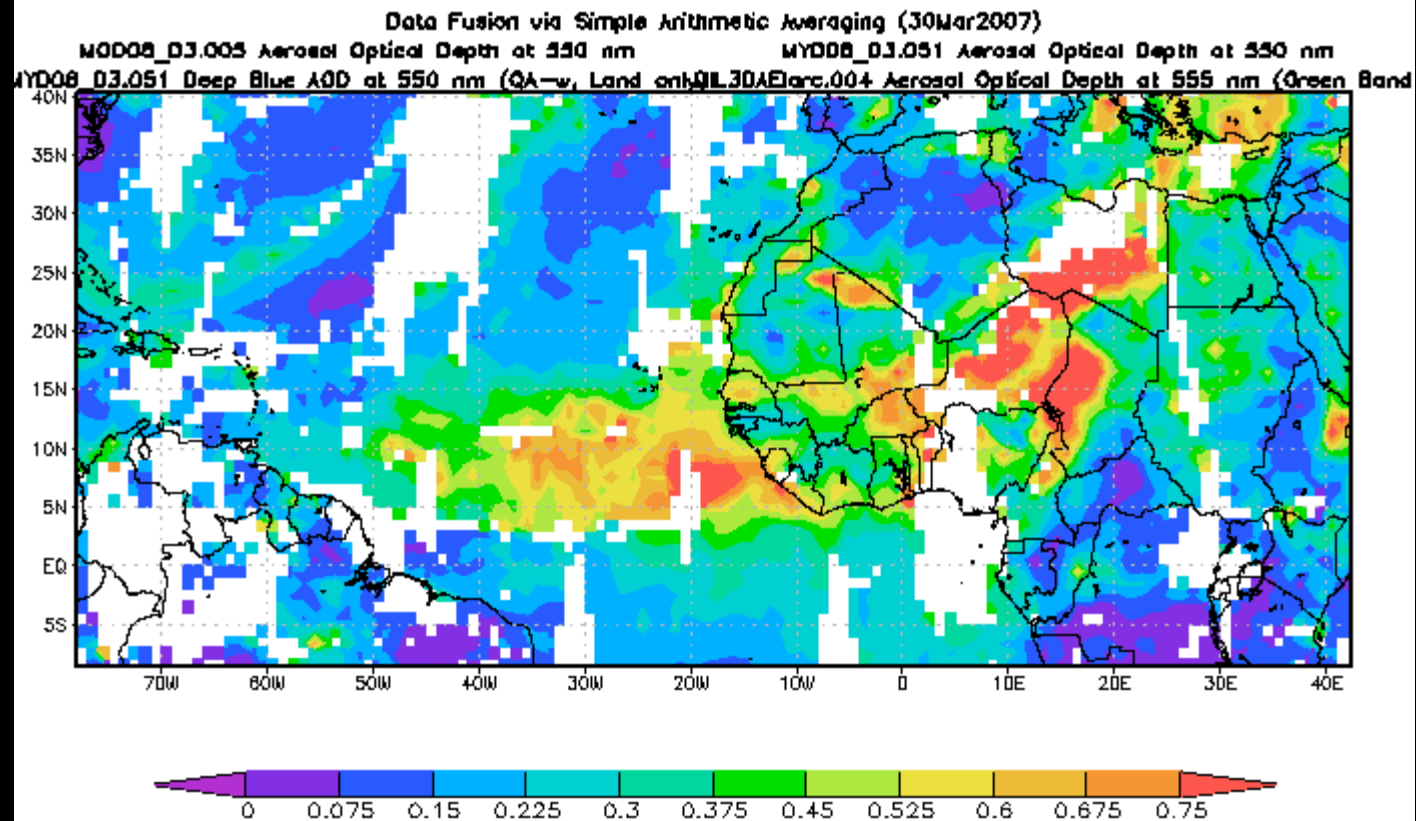








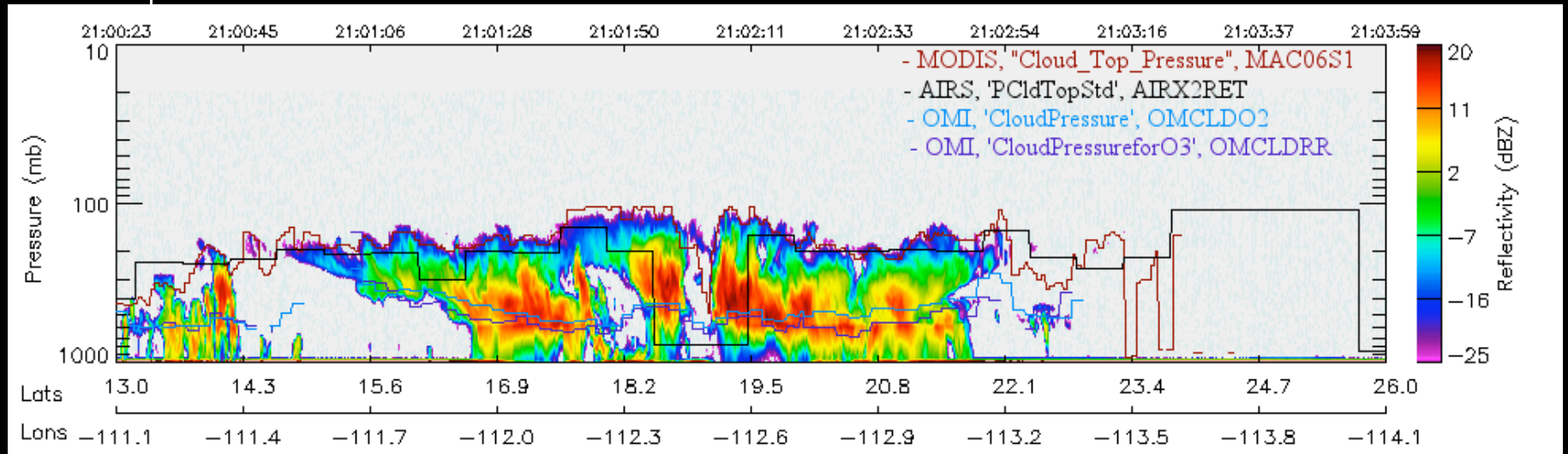
# Monitoring Aerosol Transport





# Integrating Atmospheric Measurements along the A-Train Tracks Utilizing Data from the Aqua, CloudSat and CALIPSO Missions

The A-Train Data Depot (ATDD) is to process, archive, allow access to, visualize, analyze and correlate distributed atmospheric measurements from A-Train sensors. The ATDD portal provides easy on-line data access and services for science, applications, and educational use so that users easily get exactly the data they want.

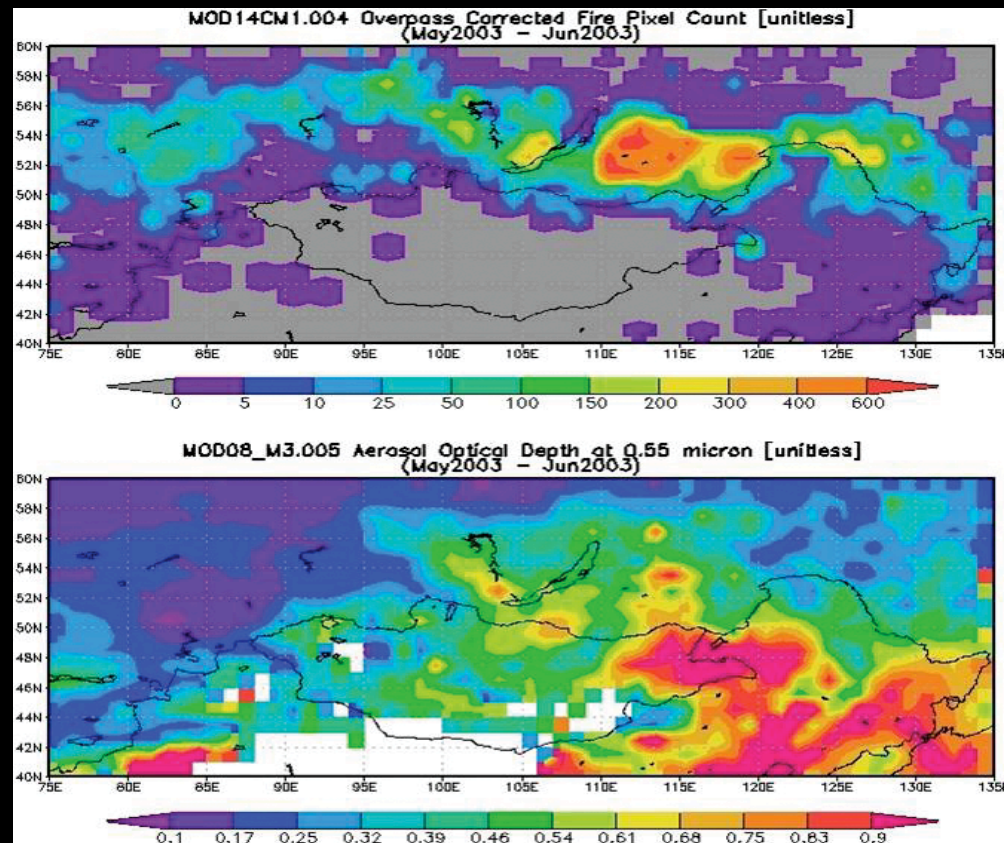




# NASA NEESPI Data Center

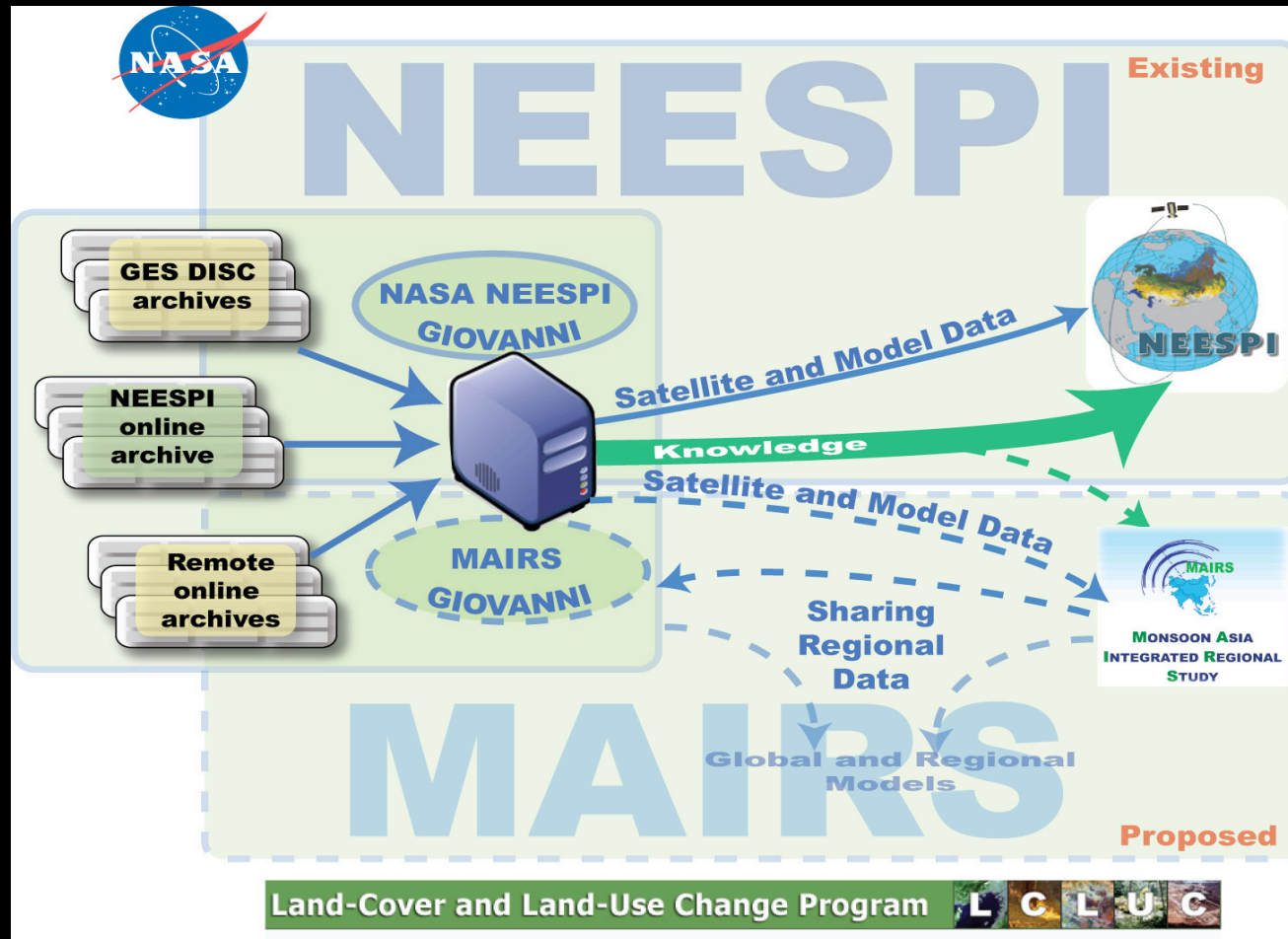
NASA Remote sensing data and related RS and model for Northern Eurasia Earth Science Partnership Initiative (NEESPI) with Giovanni.

Funding: NASA ACCESS





# NASA Data and Services Supporting Monsoon Asia Integrated Regional Study in Eastern Asia (MAIRS)



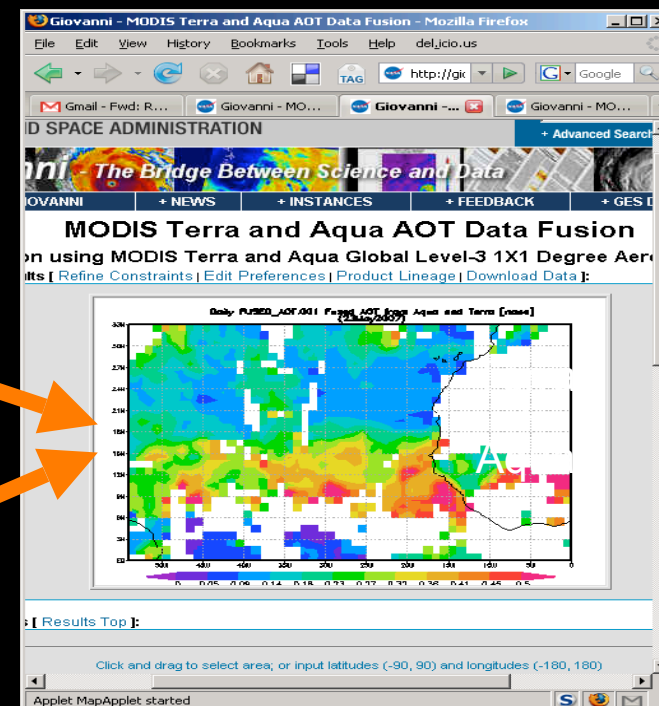
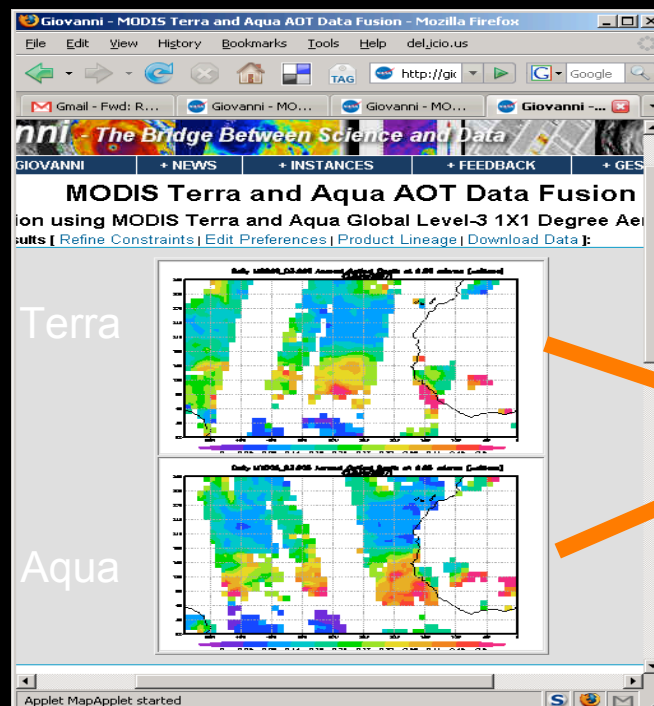
Funding: NASA LCLUC



# Long-Term Aerosol Data Records: Using Deep Blue to Synergize SeaWiFS, MODIS, AVHRR and TOMS Observations

Enable data archive, database and visualization infrastructure to manage long-term aerosol data record by applying Deep Blue Algorithm to SeaWiFS and MODIS and exploiting synergies with AVHRR and TOMS Overlapping Aerosol Time Series record.

Collaborator: Hsu



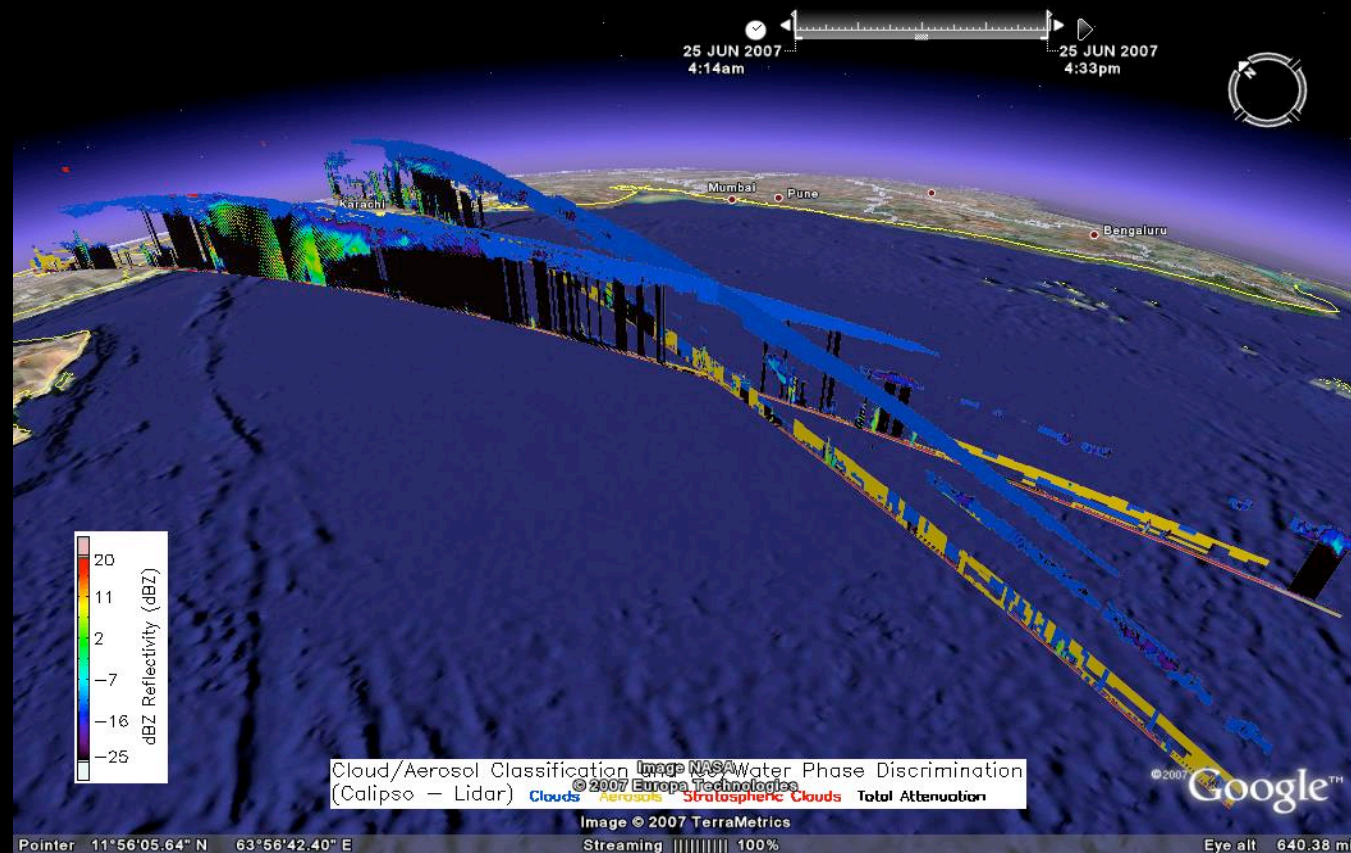




# A-Train Data in Three Dimensions

Develop vertical profile/curtain feature in Google Earth and integrate this into operational A-Train Giovanni.

Funding: NASA ACCESS

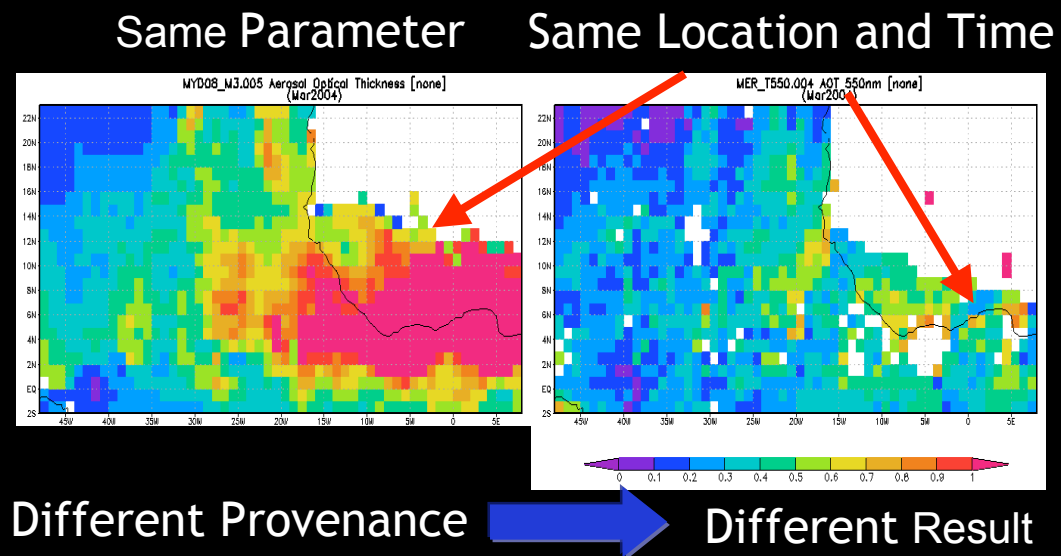




# Multi-Sensor Data Synergy Advisor (MDSA)

Expand Giovanni to include semantic web ontology system that captures scientist knowledge (rule-sets) & data quality characteristics, encode this knowledge so the Advisor can assist user in multi-sensor data analysis. Identify and present the “safe” comparisons, or the caveats for speculative comparisons.

Funding : ESTO

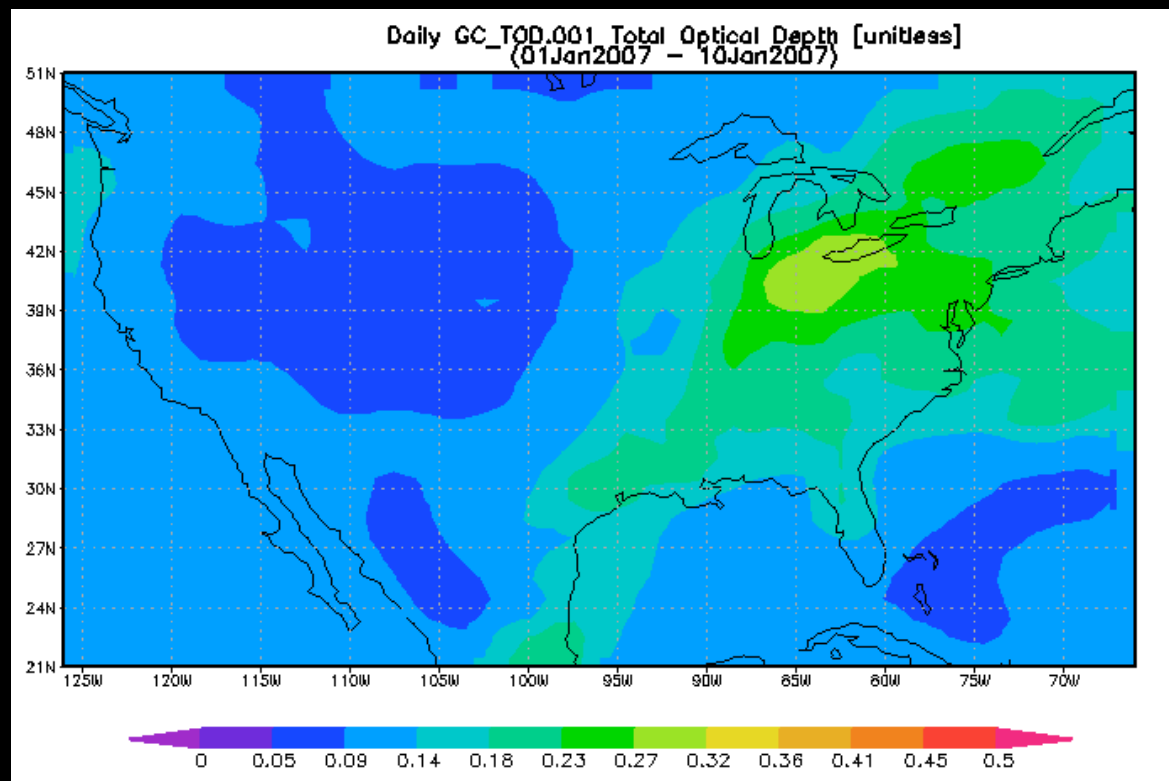


Importance of capturing and using provenance



# GOCART Data Management (Archive, Distribution and Visualization)

Provide data management capabilities for various GOCART Model Experiments. Integrate with Giovanni services for analysis and visualization and comparison with satellite observations. Collaborator: Chin

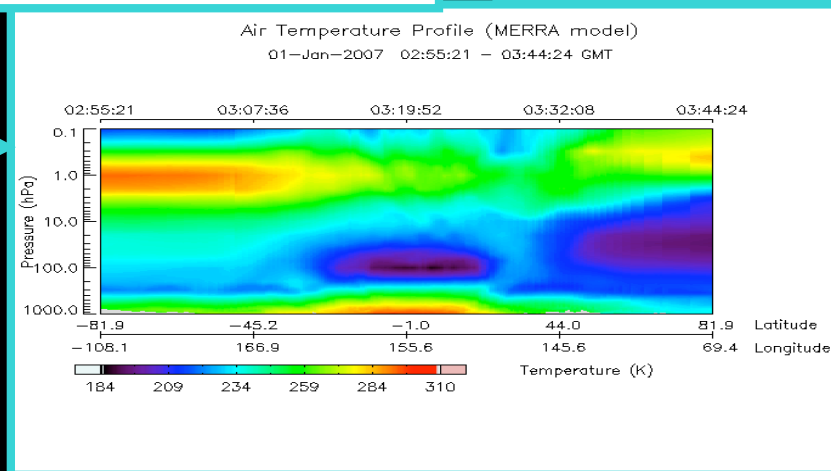
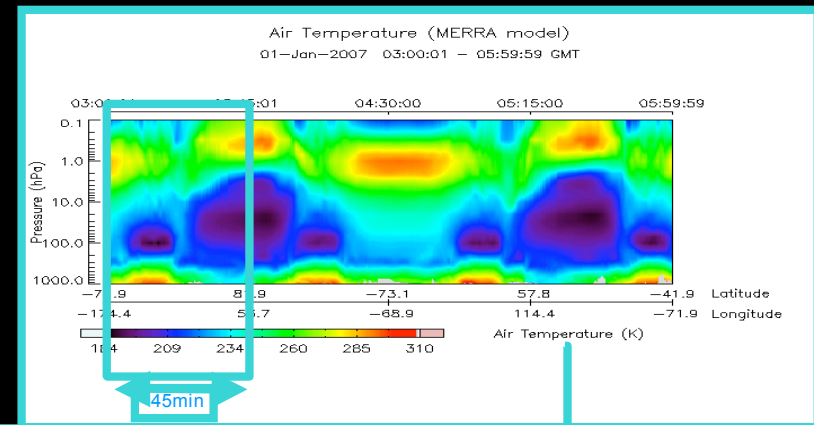
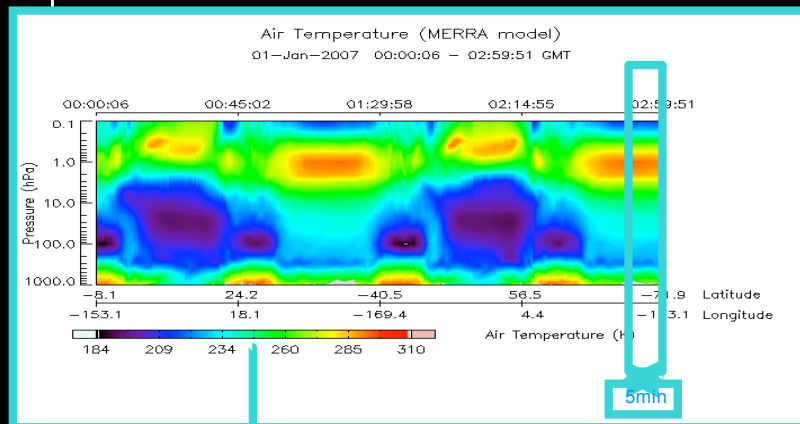






# MERRA Model Data in Giovanni

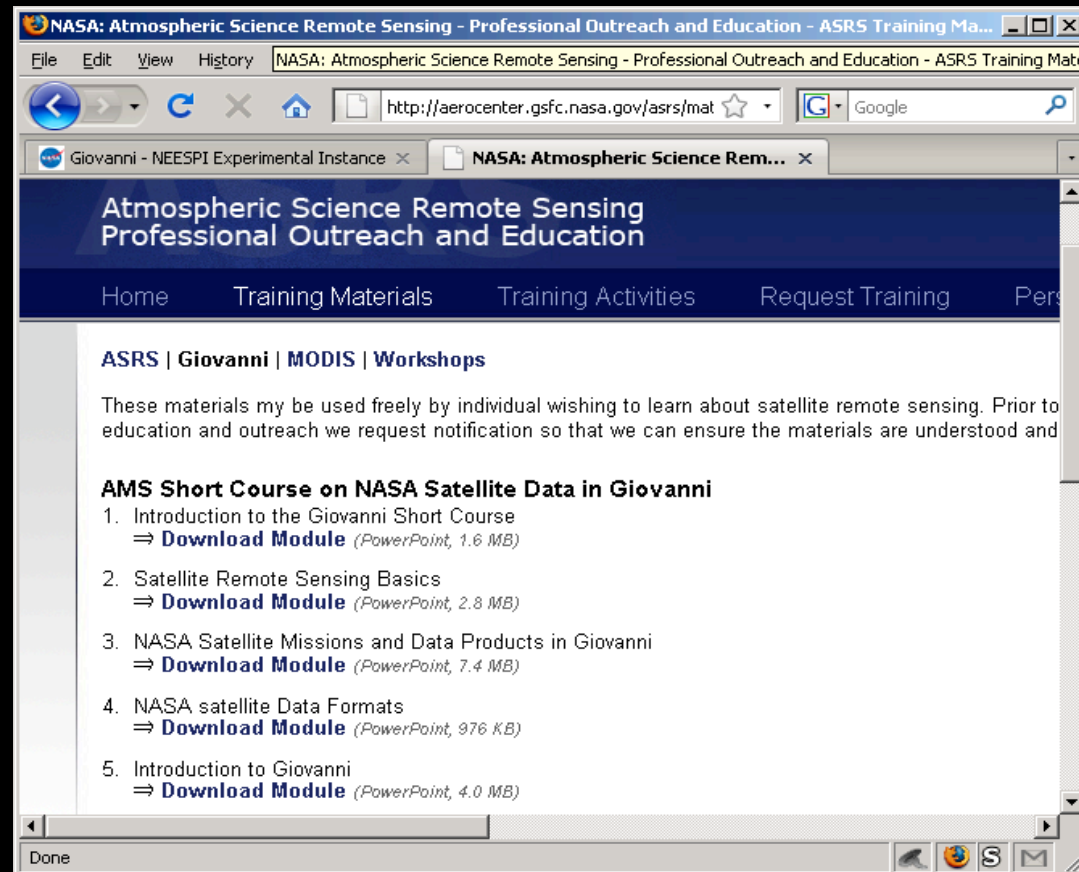
- 🌍 MERRA 2-D and 3-D data in Giovanni
  - 🌍 A-Train subset of MERRA
- Collaborator: Bosilovich





# Develop Training Modules for Using NASA Satellite Data

Funded by Lawrence Friedl of NASA HQ to develop training modules on NASA satellite data usage and lead several training workshops. The GES-DISC portion includes training on how to use Giovanni.



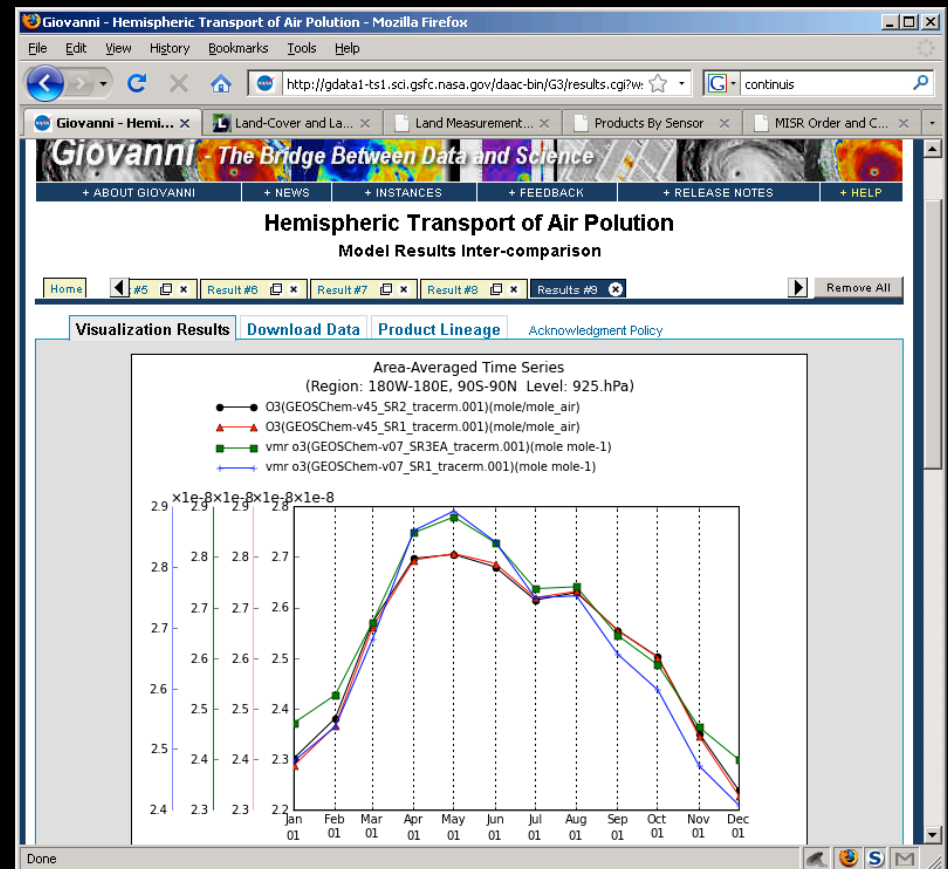


# Hemispheric Transport of Air Pollution (HTAP) Giovanni

Develop a web-based tool for Hemispheric Transport of Air Pollution (HTAP) Model Intercomparison.

Potentially expand it for comparison with remote sensing data

Funding: Friedl (HQ)  
Collaborator: Keating (EPA)



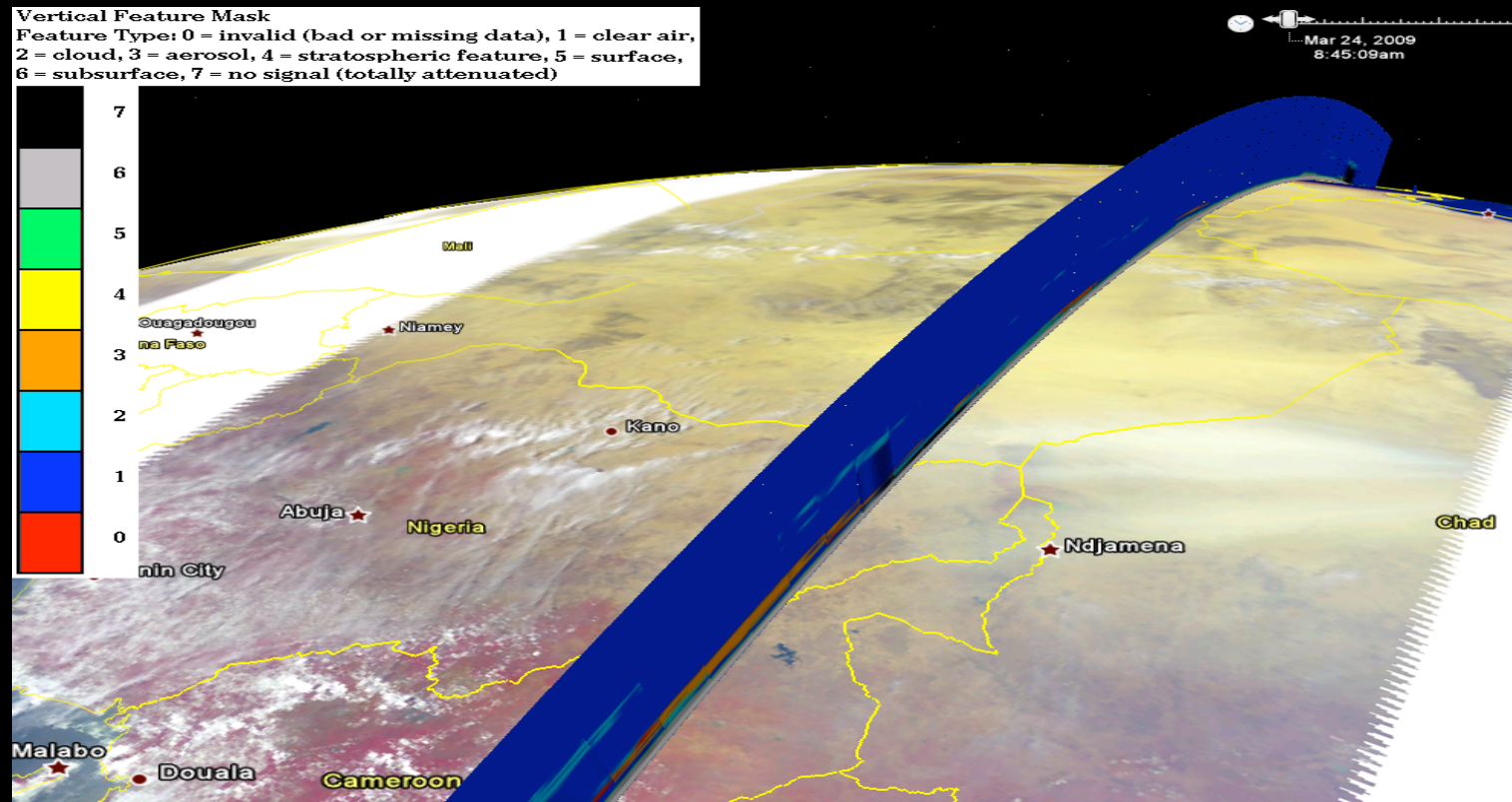


# Langley NRT (Calipso and GE)

Provide the Google Earth vertical profile option for the Near-Real-Time CALIPSO data and imagery

Funding: Friedl (HQ)

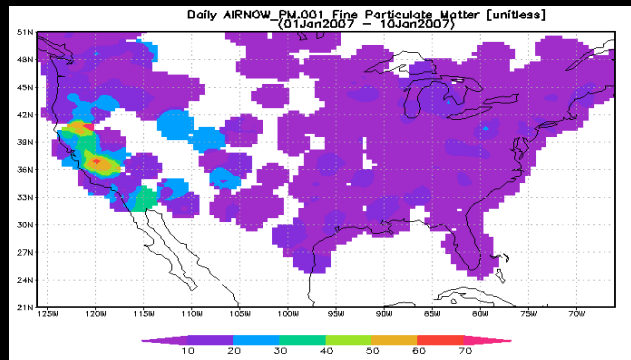
Collaborator: Trepte (LaRC)



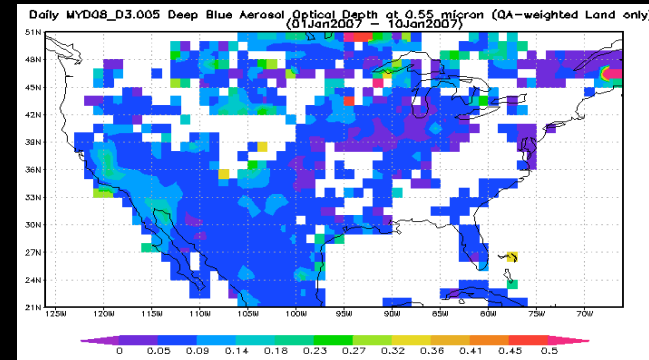


# Air Quality Multi-Sensor, Model, and Ground-Based Data Support *via* Giovanni

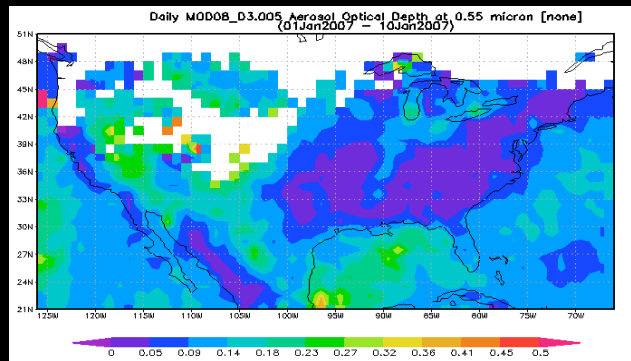
Multi-sensor, model, and ground-based data support with Air Quality Giovanni



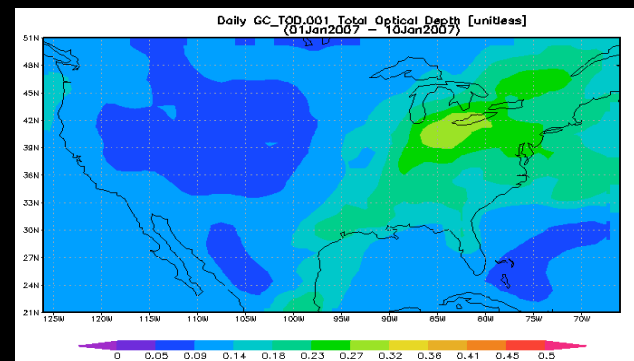
PM<sub>2.5</sub> (EPA → DataFed → Giovanni)



Deep Blue MODIS Aerosol Optical Depth



The standard MODIS AOT



GOCART AOT



# Other Funded Giovanni-Related Projects

Ocean Color Time-series Project (Original Funding: NASA REASON; Current Funding: Gregg) Maintenance of ocean color data sets in Giovanni; enhancement when possible. Use of the current resources for outreach projects, i.e. the CARSON project pilot effort. “Springboard” for other proposals, such as current Water Quality proposal, and educational proposals.

Integrated Validation, Inter-comparison and Analysis of Aerosol Products from multiple Satellites (Collaborator: Ichoku) Develop database and visualization infrastructure to provide a combined post validation of aerosol data from key satellite instruments and render their space and time characteristics transparent to Users in a comparative manner. Specifically organize the MAPSS and Aeronet data into a database that could be used to drive Giovanni web services.

Enhancing NOAA AWIPS DSS by Infusing NASA Research Results for Drought and Disaster Management (Collaborator: Indiana Univ. Purdue Univ. Indianapolis IUPUI) Use NASA satellite surface soil moisture data and recently developed new spatial data assimilation framework in conjunction with the NOAA model to generate much more accurate evapotranspiration (ET) time series to input to NWSRFS, a sub-DSS of AWIPS.

Repackage MERRA Model Data for Time-Series in Giovanni (Funding: NASA MAP) MERRA data is compacted into daily files and each daily file consists of data from multiple time segments. New functionality has to be developed to be able to unpack these files, read and plot the data from each temporal dimension for optimal data access and Giovanni use.

CERES and TES into Giovanni (Funding: NASA ESDIS) This effort is to make TES data and a targeted subset of the CERES data available in Giovanni for intercomparison with other NASA data.



# Other Mainstay Giovanni Instances

---

MOVAS - funded by Yoram Kaufman for MODIS

MISR - funded by Dave Diner

AOVAS - developed for TRMM data exploration

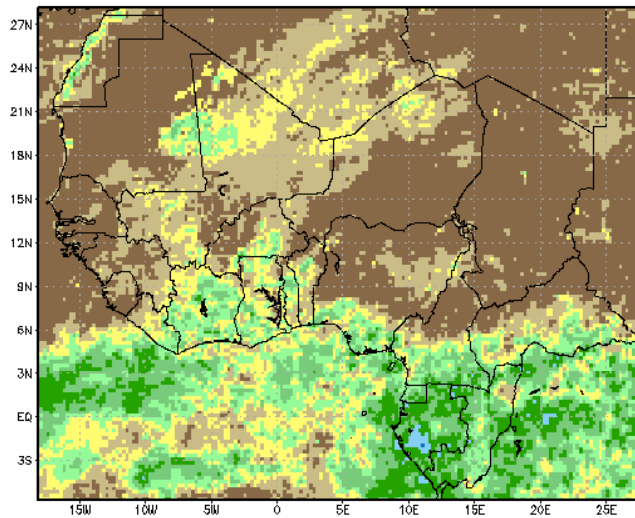




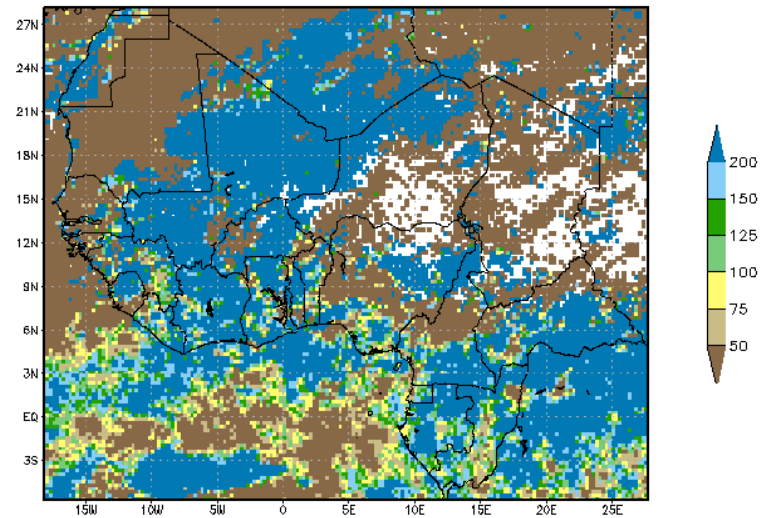
# Agriculture Online Visualization and Analysis System (AOVAS)

The Agriculture Online Visualization and Analysis System (AOVAS) is Giovanni instance providing variety of data products and analytical functions for global and regional rainfall analysis. The DISC also provides global and regional monitoring maps rainfall data from NRT TRMM and GPCP for the past 3 hours, 24 hours, 10 days, 30 days, 60 days, and 90 days.

TMPA-RT Precipitation [mm]  
(11feb2009 - 20feb2009)



TMPA-RT Decadal Percent Normal Precipitation [%]  
(11feb2009 - 20feb2009)







# Preparing for MEaSUREs Datasets

GES DISC will be responsible for archiving seven approved datasets generated by MEaSUREs PIs:

PI	Start Date	End Date	Title
Chung-Lin Shie	12-May-08	11-May-11	Reprocessing of Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) Data Set for Global Water and Energy Cycle Research
Rich McPeters	15-Jan-08	15-Jan-13	Creating a Long Term Multi-Sensor Ozone Data Record
Lucien Froidevaux	15-Mar-08	15-Mar-13	GOZCARDS: Global OZone Chemistry And Related trace gas Data records for the Stratosphere
Jay Herman	15-Mar-08	15-Mar-13	Earth Surface and Atmospheric Reflectivity Since 1979 from Multiple Satellites (TOMS, SBUV, SBUV-2, OMI, SeaWiFS, NPP, and NPOESS)
Christina Hsu	1-Apr-08	1-Apr-13	Consistent Long-term Aerosol Data Records over Land and Ocean from SeaWiFS
Eric Fetzer	15-May-08	15-May-13	A Multi-Sensor Water Vapor Climate Data Record Using Cloud Classification
Eric Wood	15-Jun-08	15-Jun-13	Developing consistent Earth System Data Records for the global terrestrial water cycle



# Preparing for MEaSUREs Datasets

- ④ Cost estimate was provided to ESDIS, loaded upfront in preparation for the first dataset to be ready in 2011
- ④ First MEaSUREs get together to be held, April 29-30  
Heard back from everybody except Eric Wood
- ④ Had discussions with NSIDC on how to make Eric Wood's Hydrologic cycle data, slated for 2 DAACs, seamlessly accessible by hydrologists
- ④ Developed the "Checklist for Supporting MEaSUREs Datasets and Services" at the GES DSC, shared with ESDIS for potential use elsewhere.